VII HYDROLOGIC BUDGET

A. Surface and Groundwater Hydrology

The hydrologic budget for a lake equates the total water input to the total water output for specified time increments during a specified period. The water flow rates through the lake are thereby quantified. The development of a hydrologic budget is essential in calculating the loading (mass per unit time) of eutrophying nutrients as well as in evaluating a lake's tolerance of these nutrients. The balance between hydrologic inputs and outputs influence the nutrient supply to the lake, the lake's water residence time, and consequently the lake's productivity and water quality. An accurate and detailed hydrologic budget will thus permit an accurate determination of current trophic status and will provide a sound basis for evaluating the effectiveness of watershed and in-lake management strategies for improving trophic status.

The quantification of the components of the Mendums Pond hydrologic budget was based on an intensive one-year stream gaging (November 1987, through October, 1988) developed as a basis for a complete hydrologic year and phosphorus budget. The budget quantifies the monthly and annual water inflow from each source to Mendums Pond. Additionally, the monthly variations of the lake's hydraulic retention (flushing) time and fraction of exchanged lake water volume are specified.

In conjunction with the hydrologic budget for Mendums Pond, mean monthly surface water discharge volumes for each station in the watershed were calculated and tabulated for the gaging year. This information is valuable for comparing the relative hydrologic (and hence nutrient) contributions from various tributary areas within the watershed. Although the annual hydrologic budget entails a twelve month period, the extended study period allowed biologists to collect 35 months of flow data. This data is tabulated in Appendix VII-1. Section B describes the field monitoring program. Section C presents the hydrologic budget and other hydrologic data, and discusses their development.

B. Field Monitoring Program

Field investigations and data collectionoccurred during the period from October 1987 through August 1990. The actual gaging year budget presented in this chapter will encompass a complete year, beginning November 1, 1987 and ending October 31, 1988.

1. Stream Gaging and Precipitation Monitoring

Ten inflowing tributaries, two outlet stations and two seasonal discharges were monitored for flow within the Mendums Pond watershed (Figure IV-1). Data consisting of staff gage readings and actual flows were collected either on a tweice a month or weekly basis depending on the time of year and station. To determine the stage-discharge relationships at each station, measurements of flow were obtained using current meters at least once per week for periods April through December. Stage-discharge relationships and discharge summaries for each station can be found in Appendix VII-1.

Direct discharge measurements do have some disadvantages. Schroeder (1979) and Dennis (1986) point out that periods of peak discharge during storm events and spring meltoff may be missed, resulting in lower estimates of inflow and thus nutrient loading. In fact, both spring meltoff and sotrm events could represent a high percent of the total hydrologic and phosphorus budget in a given watershed.

A variety of methods have been utilized to calculate runoff and water budgets. Each method has drawbacks. Estimates of flow rates on tributary streams from interpolation of flows from neighboring watersheds can have significant errors (Kemp, 1979). Dillon (1975) cautions against predicting water budgets through emperical methods using long-term runoff maps. He suggests that measurement versus estimation provides more accurate results and should be utilized where possible. In general, values will usually fall within 25% of those predicted using long-term runoff maps.

Daily rainfall and water equivalent snowfall data (Chapter III) were collected from NOAA climatological stations in Concord, Epping, and Durham, New Hampshire. The Durham station is within 20 miles of the study area. Monthly rainfall and water equivalent snowfall data for Mendums Pond is presented in Table III-2. Table VII-1 presents the surface volume precipitation upon Mendums Pond.

Table VII-1

Mendums Pond Surface Volume Precipitation

(Mean monthly precipitation) (lake surface area (1,023,900 m^2))

Month	Mean Monthly Water Equiv. (in)	Mean Monthly Water Equiv. (m)	Lake Precipitation Volume (m^3)	Lake Precipitation Volume (10^3 m^3)
Nov '87	2.60	0.066	67,577	67.58
Dec	2.15	0.055	56,314	56.31
Jan '88	1.06	0.027	27,645	27.64
Feb	2.37	0.060	61,434	61.43
Mar	2.38	0.060	61,434	61.43
Apr	4.22	0.107	109,557	109.56
May	4.02	0.102	104,438	104.44
Jun	2.29	0.058	59,386	59.39
Jul	8.13	0.206	210,923	210.92
Aug	5.94	0.151	154,609	154.61
Sep	2.63	0.067	68,601	68.60
Oct	3.22	0.082	83,960	83.96
Total	41.01	1.042	1,066,904	1,066.90

2. Groundwater

One area which is poorly understood, and in which little information exists, is groundwater seepage and its nutrient contribution to surface waters. In many cases, groundwater seepage may repersent a significant input of water and nutrients to an aquatic system. Recent, as well as past, field work has demonstrated significant interchange between lakes and groundwater lenses. Many lakes, rather than being isolated from groundwater bodies by lake bottom sediments, are closely connected with them, forming integral parts of dynamic groundwater flow systems (McBride and Pfankuch, 1975). Nitrogen and phosphorus are direct contributors to the productivity of lakes and streams. These nutrients are often encountered in high concentrations in groundwater and may represent a significant percentage of the nutrient loading to a given lake.

Lee (1972) and Connor (1979) found that seepage flow patterns generally showed an exponential decrease with increasing distance from shore. Shallow groundwater contributes the major volume of seepage to a lake.

Downing and Peterka (1978) and Connor (1979) observed that seepage meters collected more groundwater during rainy periods as compared to drier periods during the summer months. It is speculated that as the water table rises due to rainfall, groundwater is forced by the hydraulic gradient into the lake.

Direct measurements of groundwater through the placement of seepage meters can quantify one factor in the hydraulic budget. In the same way, analysis of the seepage can supply important chemical information that can be utilized in nutrient budget calculations.

Groundwater seepage was measured directly in Mendums Pond. Seepage meters were constructed of fifty-five gallon drums (208.2L) cut to form two sections approximately 44cm in height for insertion into organic muck sediments. For harder sandy sediments, drums of 20cm height were utilized. Sterile bacterial whirl packs, secured to one-holed rubber stoppers in the top of the drum by hard plastic tubing, were used as seepage collection devices (Connor and Belanger, 1981). With the exception of one location, meters were placed at single site locations. One transient was set up to measure seepage rates in deeper waters. The rocky shoreline bottom made it difficult to place seepage meters in moderately deep sections of the pond. Sixteen study sites were established within the pond's perimeter (Figure VII-1). Samples were collected from July of 1988 through October of 1989.
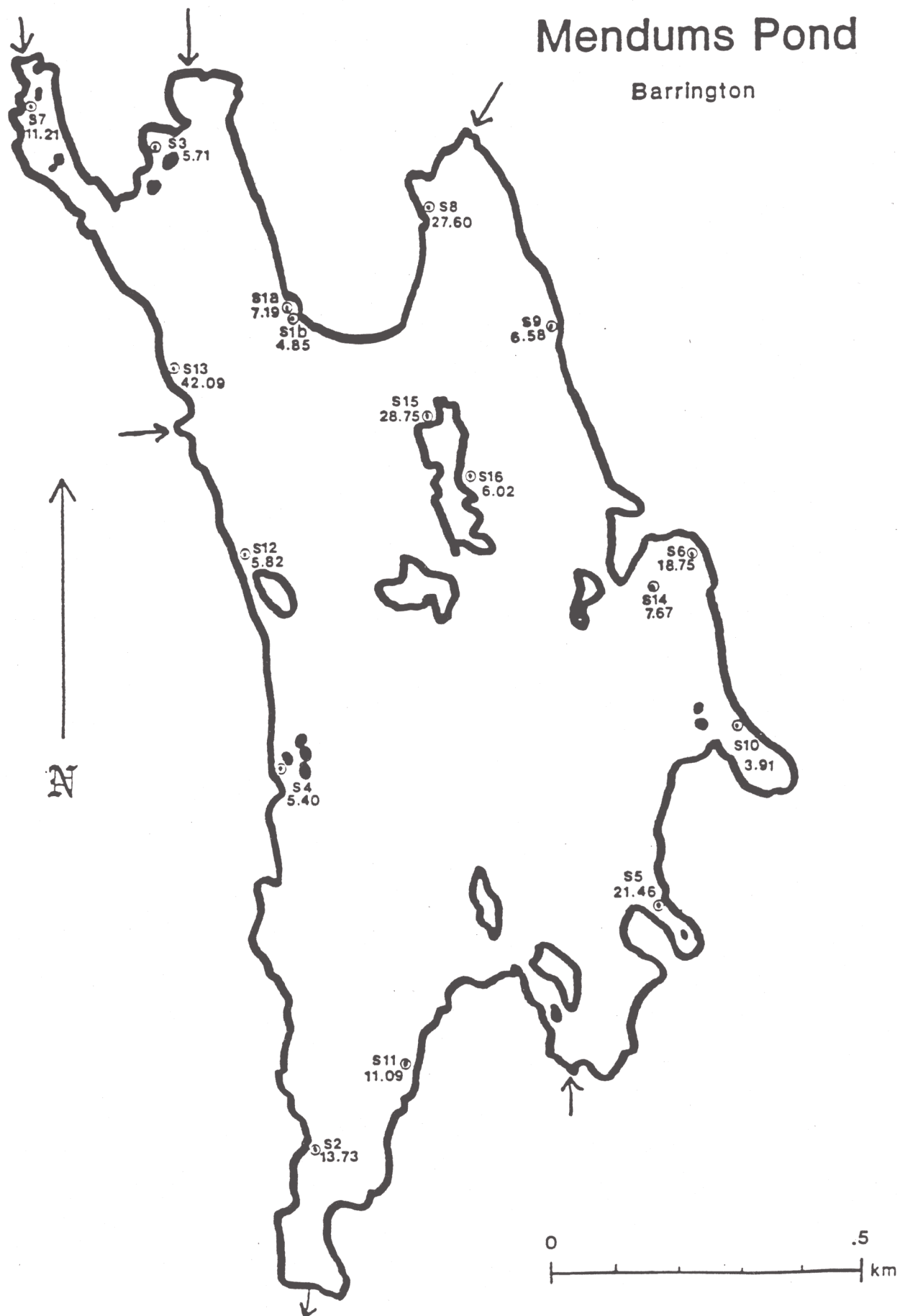
Mendums Pond

Barrington

S7
11.21

S3
5.71

S8
27.60

S18
7.19

S1b
4.85

S9
6.58

S13
42.09

S15
28.75

S16
6.02

S12
5.82

S6
18.75

S14
7.67

N

S4
5.40

S10
3.91

S5
21.46

S11
11.09

S2
13.73

0   .5

km

Figure VII-1 Seepage Meter Site Locations, Mean Annual Seepage Rates (L/m^2/day)

Seepage rates were measured for the hydrologic budget by occluding the tubing of the collection bag, attaching it to the seepage meter tubing an dreleasing the occlusion clamp (Figure VII-2). AFter the measurement interval, the volume of water obtained from the collection device was measured. The seepage rate was calculated by subtraction of the initial volume and conversion of this collected volume (mL) to liters per square meter per day ($L/m^2/day$). Mean annual seepage rates were calculated for each of the areas surrounding each seepage meter (Figure VII-1). The areal addition of individual mean annual seepage rates resulted in total groundwater seepage for the entire sediment area of Mendums Pond for the November 1987 through October 1988 period.

Raw data and average seepage rates, computed from over 100 seepage measurements, are presented in Appendix VII-2.

Seepage rates in Mendums Pond were greatest at meter 13, the northwest section (mean seepage rate = 42 $L/m^2/day$). Seepage rates were variable throughout the shoreline. The short transect represented by meters 6 and 14 demonstrate that groundwater seepage rates decreased with increasing distance from shore which has previously been documented by other researchers (Lee 1977, Fellows 1978, and Connor 1979). It is in the deeper sections of the lake where groundwater recharge zones are often located.

C. Hydrologic Budget Components

THe hydrologic budget for Mendums Pond watershed, equating all measurble inflowing and outflowing waters over a designated period of time, were determined by the following equation:

Inflow volume = outflow volume
Specifically for Mendums Pond:
$Q_{ia} 1...12 + R + P + GWi = Qo + EV + GWo$

Where,

Qi_1 = Wood Road Brook
Qi_2 = Perkins Brook
Qi_3 = McDaniels Brook

BAG

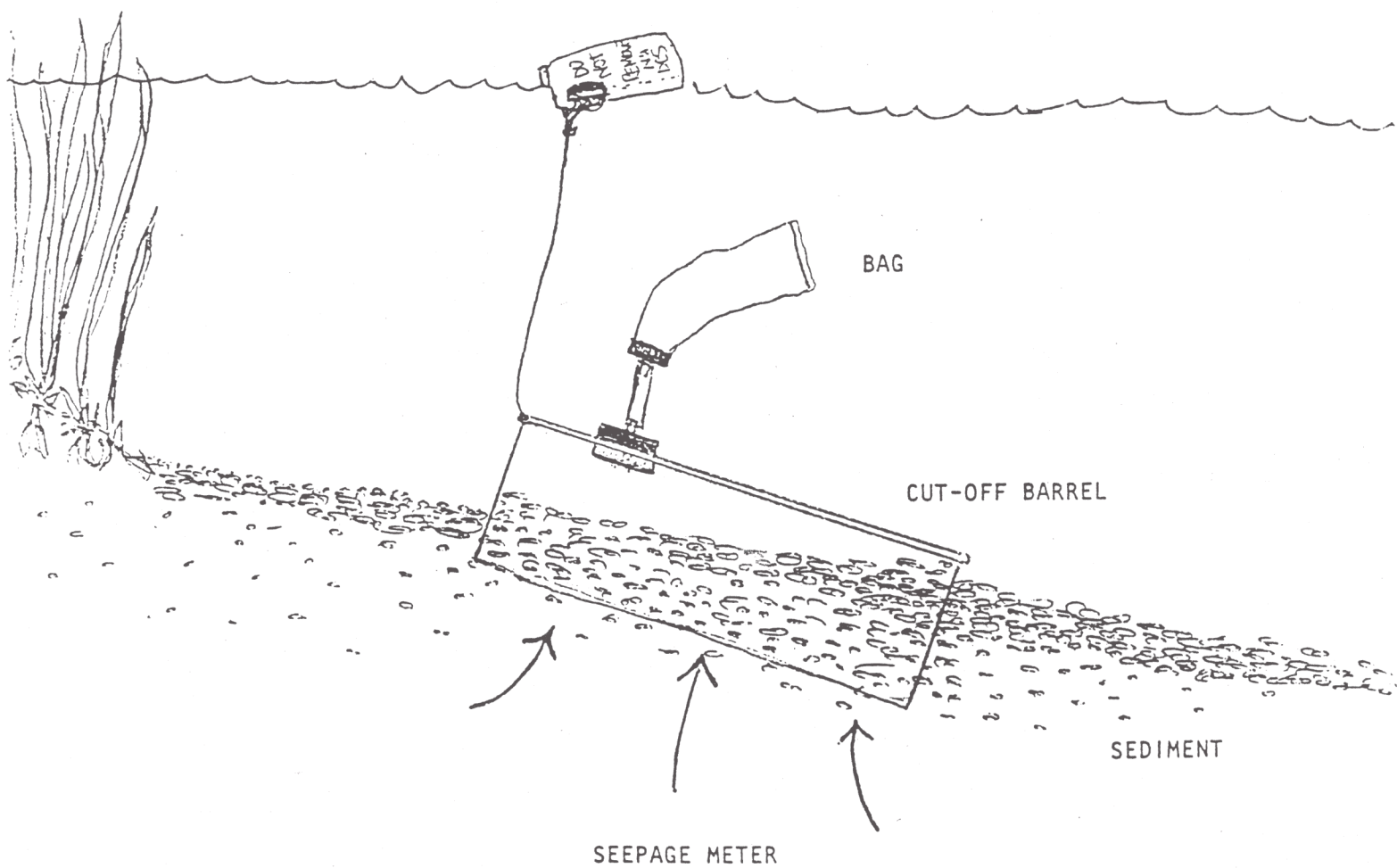CUT-OFF BARREL

SEDIMENT

SEEPAGE METER

Figure VII-2 Seepage Meter Diagram, Operation Direct Method

Qi_4 = Golden Brook

Qi_5 = Howe Brook

Qi_6 = Howe II Brook

Qi_7 = Powerline Brook

Qi_8 = Little Powerline Brook

Qi_9 = Bridge Brook

Qi_{10} = Little Bridge Brook

Qi_{11} = Storm Brook

Qi_{12} = Seasonal Brook

R = Surface water runoff from the direct drainage area

P = Precipitation volume on lake

GWi = Groundwater inflow (seepage)

Qo_1 = Outflow (combined lake outflow from dam)

Qo_2 = Spillway outflow

EV = Lake surface evaporation

GWo = Groundwater outflow (recharge)

Each component of this budget is in volumeric units of 10^3m^3 (1000 cubic meters).

1. Hydrologic Budget for Study Period (1987-1988)

The monthly components of the budget were derived from the aforementioned stream monitoring stations.

Mendums Pond has been ten direct annual discharges (Qi_1 through Qi_{10}), and two seasonal/storm event brooks (Qi_{11} and Qi_{12}). Monthly flow values of the twelve direct discharges to Mendums are presented in Table VII-2. These flow values were converted to metric units for incorporation into the hydrologic budget. Staff gage recordings, flows, flowdates and the status of each station are shown in Appendix VII-3.

Groundwater seepage could have a significant input to a water budget (Connor, 1979). Groundwater seepage was measured directly during the three year study period.

Direct runoff (R) was measured by estimating the area around the lake which drained directly into the water body, and multiplying this number by the runoff (m/yr) obtained from the Knox and Nordenson Atlas (1955).

The total volume of precipitation on a lake (P lake) is the product of the precipitation (meters) times the lake area. Both rainfall and snowfall depths (water equivalents) were collected from records at several NOAA weather stations surrounding Barrington (Table VII-1).

Table VII-2

Mean Monthly Hydrologic Discharge Values for Mendums Pond Tributaries ($10^3 m^3$)

Month	Wood Rd Brook	Perkins Brook	McDaniels Brook	Golden Brook	Howe Brook
Nov 87	22.8	139.5	51.4	18.4	73.4
Dec 87	98.6	523.4	189.6	22.8	30.3
Jan 88	45.5	273.1	91.0	22.8	22.8
Feb 88	95.9	685.2	171.3	27.4	27.4
Mar 88	113.8	690.3	250.3	30.3	37.9
Apr 88	95.4	535.9	212.9	22.0	22.0
May 88	121.4	477.9	204.8	22.8	30.3
Jun 88	7.3	73.4	22.0	0.0	7.3
Jul 88	91.0	151.7	83.4	37.9	22.8
Aug 88	91.0	493.1	121.4	22.8	22.8
Sep 88	29.4	176.2	51.4	2.9	36.7
Oct 88	15.2	402.0	45.5	15.2	7.6
Total	827.3	4621.7	1495.0	245.3	341.3
mean	68.9	385.1	124.6	20.4	28.4

Table VII-2
Mean Monthly Hydrologic Discharge Values for Mendums Pond Tributaries ($10^3 m^3$) (continued)

Month	Howe Brook II	Powerline Brook	Little Powerline	Bridge Brook	Little Bridge	Storm Brook	Seasonal Brook
Nov 87	7.3	7.3	14.7	7.3	7.3	0.0	7.3
Dec 87	7.6	22.8	15.2	22.8	3.0	0.0	7.6
Jan 88	7.6	37.9	15.2	7.6	0.0	0.0	7.6
Feb 88	6.9	27.4	13.7	13.7	0.0	0.0	6.9
Mar 88	7.6	37.9	15.2	22.8	7.6	7.6	15.2
Apr 88	7.3	29.4	14.7	22.0	7.3	2.9	7.3
May 88	0.0	30.3	15.2	22.8	7.6	0.0	15.2
Jun 88	7.3	7.3	2.9	7.3	0.0	0.0	7.3
Jul 88	7.6	22.8	7.6	22.8	7.6	0.0	7.6
Aug 88	0.0	22.8	7.6	15.2	7.6	15.2	7.6
Sep 88	0.0	7.3	0.0	14.7	0.0	0.0	0.0
Oct 88	7.6	7.6	3.0	15.2	7.6	0.0	7.6
Total	66.8	261.1	125.0	194.2	55.6	25.7	97.2
Mean	5.6	21.8	10.4	16.2	4.6	2.1	8.1

Stream outflow (Qo) is the measured discharge from the Mendum's dam and spillway converted to meteric volume per month.

Evaporation (EV) rates were not measured directly at Mendums Pond. Pan evaporation records for the NOAA weather station at Massabesic Lake (Manchester, New Hampshire), were obtained for the study period (Table VII-3). A pan coefficient of 0.77 was selected for the study region from the NOAA Atlas (1979). Evaporation calculations and monthly evaporation rates at Mendums Pond are shown in Table VII-3.

Groundwater outflow recharge zones (GWo) are difficult to measure unless reliable seepage meter data, including several meter treansects to the deeper portions of the lake, are available. Groundwater recharge was estimated to be a small portion of the water budget. This is because the surrounding groundwater gradients were predominantly oriented into teh lake basin, and the zone through which groundwater outlfow occurs was small.

The hydrologic budget for each month of the study period for Mendums Pond is presented in Table VII-4. Monthly water volume exchanges are graphically demonstrated in Figure VII-3. Mendums Pond received its peak inflow volume during March, when much of the watershed snow meltwater flowed into the pond's tributaries. The four months of February, March, April and May accunted for 47 percent of the total inflow of water to Mendums Pond. This period of time inluded snow meltwater and fairly high precipitation. By June, flow volumes decreased substantially but rose again in July and August as fourteen inches of precipitation fell in the area over the two month period. Water volume to the pond leveled off during the final two months of the study year.

Figure VII-4 demonstrates the seasonal tributary flow distribution as percent of the total budget. Water volume to the pond peaked during the spring with 36 percent of the total input. Seasonal summer high flow accounted for 21 percent of the flow distribution. The lowest input volume to Mendums (16 percent) occurred during the fall. Seasonal winter flows to Mendums Pond were higher than expectd during this usually cold period when runoff is minimal due to frozen conditions. The high volume (27 percent) may be a result of warmer temperatures in both December and February allowing for more meltwater to reach the pond.

Table VII-3
Mendums Pond Monthly Pan Evaporation Rates
(Pan Coef) (Lake Surface Area) (Monthly Evaporation)

Month	Pan Evaporation rates (in.)	Pan Evaporation rates (m)	EV(m3)	(EV) (103m3)	(EV)(Pan Coef.)
Nov 87	0.00	0.00000	0.00	0.00	0.00
Dec 87	0.00	0.00000	0.00	0.00	0.00
Jan 88	0.00	0.00000	0.00	0.00	0.00
Feb	0.00	0.00000	0.00	0.00	0.00
Mar	0.00	0.00000	0.00	0.00	0.00
Apr	0.30	0.008	7,781.6	7.76	5.99
May	4.64	0.118	120,717.8	120.72	92.95
Jun	6.59	0.167	171,400.9	171.40	131.98
Jul	5.82	0.148	151,332.4	151.33	116.53
Aug	4.60	0.117	119,591.5	119.59	92.09
Sep	3.64	0.093	94,710.8	94.71	72.93
Oct	2.02	0.051	52,526.1	52.53	40.45
Total	27.61	0.701	718,061.1	718.06	552.91

Table VII-4

Mendums Pond Hydrologic Budget for Gaging Period
(Nov, 1987-Oct, 1988) Water Volume ($10^3 m^3$)

Component	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean Monthly	Annual
Qi_1	22.8	98.6	45.5	95.9	113.8	95.4	121.4	7.3	91.0	91.0	29.4	15.2	68.9	827.3
Qi_2	139.5	523.4	273.1	685.2	690.3	535.9	477.9	73.4	151.7	493.1	176.2	402.0	385.1	4621.7
Qi_3	51.4	189.6	91.0	171.3	250.3	212.9	204.8	22.0	83.4	121.4	51.4	45.5	124.6	1495.0
Qi_4	18.4	22.8	22.8	27.4	30.3	22.0	22.8	0.0	37.9	22.8	2.9	15.2	20.4	245.3
Qi_5	73.4	30.3	22.8	27.4	37.9	22.0	30.3	7.3	22.8	22.8	36.7	7.6	28.4	341.3
Qi_6	7.3	7.6	7.6	6.9	7.6	7.3	0.0	7.3	7.6	0.0	0.0	7.6	5.6	66.8
Qi_7	7.3	22.8	37.9	27.4	37.9	29.4	30.3	7.3	22.8	22.8	7.3	7.6	21.8	261.1
Qi_8	14.7	15.2	15.2	13.7	15.2	14.7	15.2	2.9	7.6	7.6	0.0	3.0	10.4	125.0
Qi_9	7.3	22.8	7.6	13.7	22.8	22.0	22.8	7.3	22.8	15.2	14.7	15.2	16.2	194.2
Qi_{10}	7.3	3.0	0.0	0.0	7.6	7.3	7.6	0.0	7.6	7.6	0.0	7.6	4.6	55.6
Qi_{11}	0.0	0.0	0.0	0.0	7.6	2.9	0.0	0.0	0.0	15.2	0.0	0.0	2.1	25.7

Table VII-4 (continued)
Mendums Pond Hydrologic Budget for Gaging Period
(Nov, 1987-Oct, 1988) Water Volume ($10^3 m^3$)

Component	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Mean Monthly	Annual
Qi_{12}	7.3	7.6	7.6	6.9	15.2	7.3	15.2	7.3	7.6	7.6	0.0	7.6	8.1	91.2
R	27.0	22.0	0.0	0.0	49.0	63.0	45.0	27.0	89.0	67.0	27.0	36.0	37.7	452.0
P Lake	67.6	56.3	27.6	61.4	61.4	109.6	104.0	59.4	210.9	154.6	68.6	84.0	88.8	1065.8
Gwi	21.0	18.0	9.0	21.0	21.0	37.0	35.0	20.0	71.0	52.0	23.0	28.0	29.6	356.0
Total	472.3	1040.0	567.7	1158.2	1367.9	1188.7	1132.7	248.5	833.7	1100.7	437.2	682.1	852.5	10,229.7
QO_1	*1387.5	*1029.0	*993.7	*1083.6	*7.6	*7.3	7.6	7.3	7.6	7.6	7.3	469.1	418.0	5015.2
QO_2	*---	*---	*---	*---	*---	*800.2	1168.2	110.1	634.6	946.0	579.9	145.5	365.4	4384.5
EV	0.0	0.0	0.0	0.0	0.0	6.0	93.0	132.0	116.5	92.1	72.9	40.5	46.1	553.0
GWO	35.0	11.0	20.0	8.0	2.0	24.0	0.0	0.0	75.0	55.0	20.0	27.0	23.1	277.0
Total	1422.5	1040.0	1013.7	1091.6	9.6	837.5	1268.8	249.4	833.7	1100.7	680.1	682.1	852.5	10,229.7

*Pond water level manipulated by NHDES personnel (drawdown/refill via dam boards)

Mendums Pond
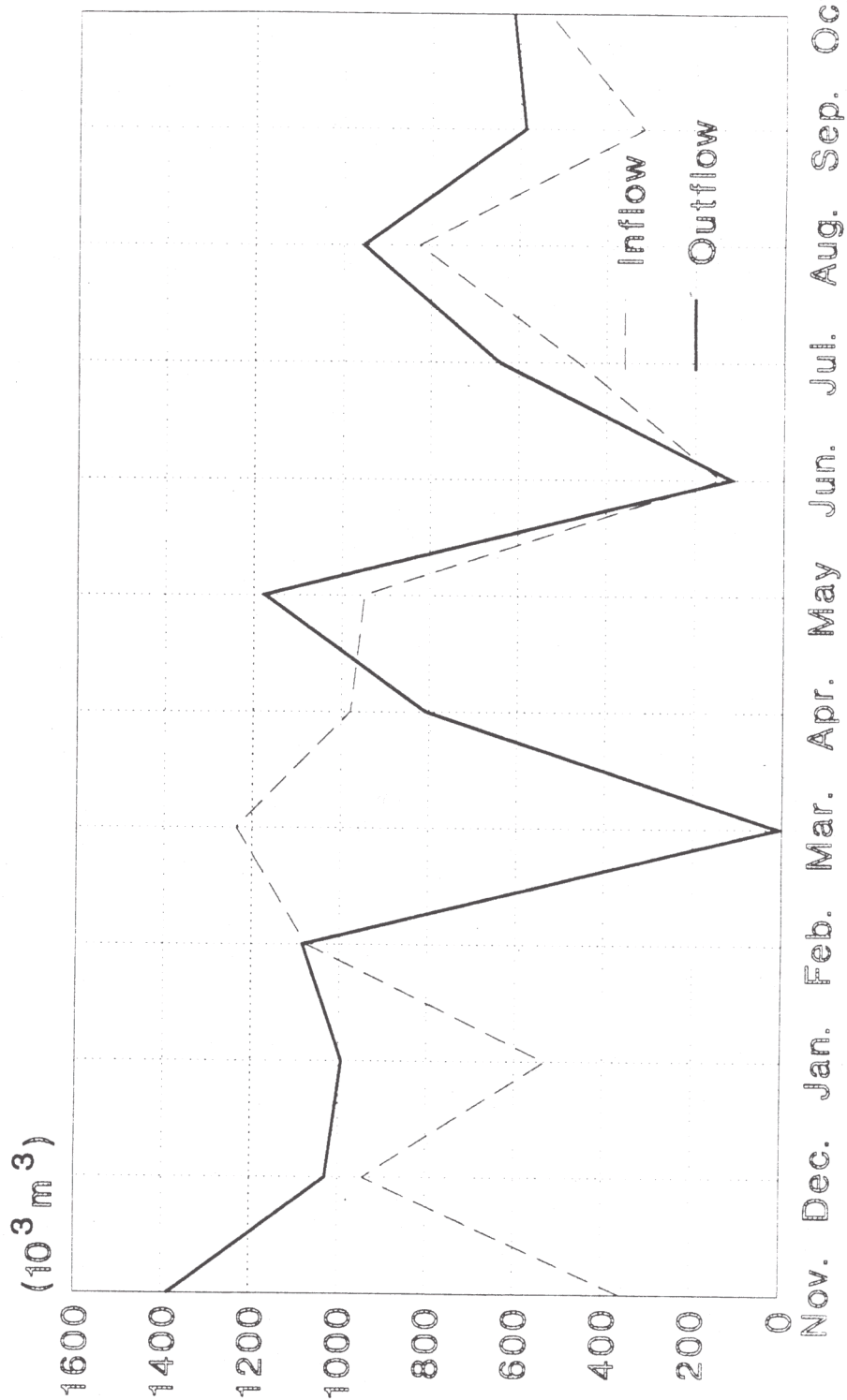## Monthly inflow \ outflow values

Figure VII-3 Mendums Pond Monthly Water Volume Exchanges

1987 - 1988

Mendums Pond
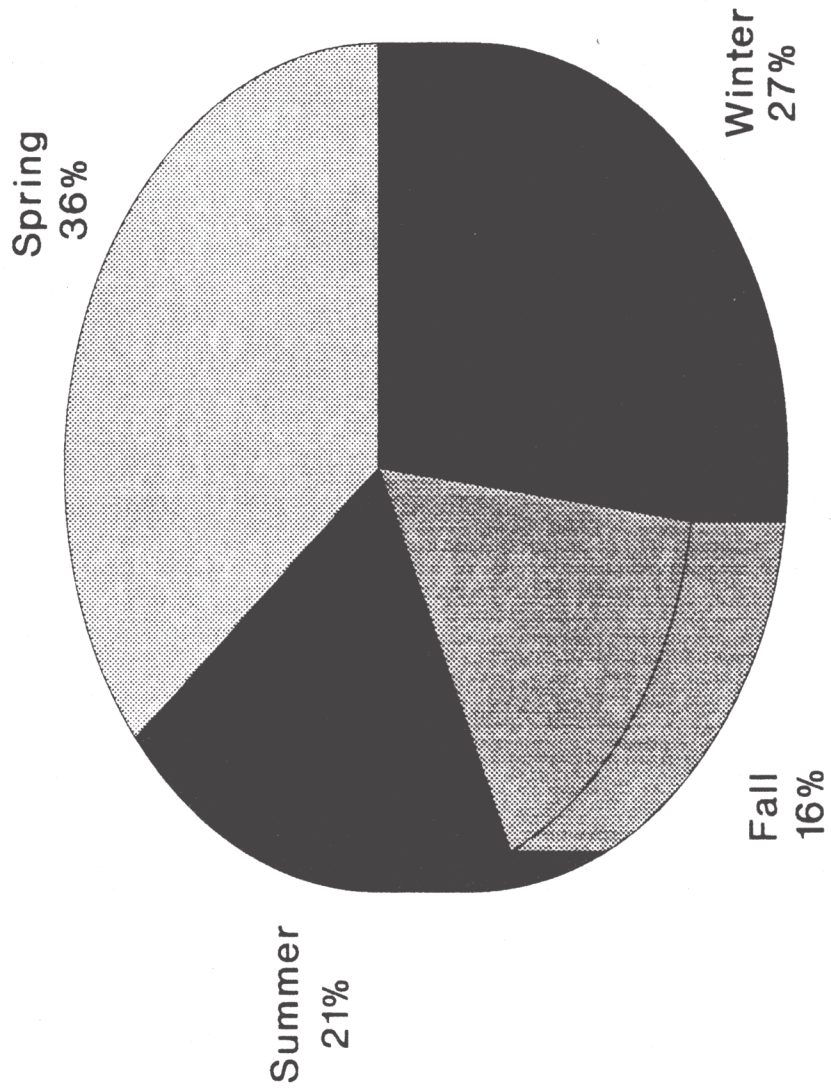## Seasonal tributary inflows

Figure VII-4 Seasonal Tributary Flow Distribution as Percent of Total Budget

Figure VII-5 displays the relative annual volume of each tributary flow to Mendums Pond. Perkins Brook, which drains Round Pond, contributed 55 percent of the tributary inflow to Mendums Pond. McDaniels Brook, located on teh North East shore and drains the upper Round Ponds, was responsible for 18 percent of the tributary flow to Mendums Pond. Wood Road Brook located on the ponds western shore was the only other brook contributing ten percent or more of the total tributary flow to Mendums Pond. The remaining nine tributaries made up 17 percent of the study year tributary flow.

Figure VII-6 depicts the relative annual volumes of each inflowing component of the hydrologic budget for Mendums Pond. Tributary flow accounted for 8356 10^3m^3 of the total 10,229 10^3m^3 flow or 83 percent of the inflowing water. Ten percent of the hydrologic budget was contributed by direct lake surface precipitation. Over half of this precipitation occurred during a four month period, April, May, July and August. In most cases, much of the direct runoff occurred in March and April when the ground was impermeable to water because of its frozen condition, and snowmelt was at its maximum. By late spring through mid fall, the ground has the capacity to contain or absorb much of this rain water, especially in low and intermediate storm events. Direct runoff was higher during July than expected because of heavy rains and saturated soil conditions.

Groundwater seepage accounted for four percent of the hydrologic budget. On a seasonal basis, groundwater seepage rates increase during late spring with the replenishment of the water table with snowmelt. The summer months reflect lesser seepage rates but are more variable due to summer storm events. High seepage rates occurred in Mendums during July corresponding to the heavy rainfalls. Seepage rates tend to rise during the usually wet New England fall season. The winter months usually reflect lower seepage as a result of frozen ground and snowfall as opposed to rainfall.

Mean monthly discharge values from Mendums Pond are presented in Table VII-5, while Figure VII-7 demonstrates the seasonal outflow pattern. Ponds, such as Mendums, that have dam structures and have a water drawdown and recovery period are difficult to budget hydrologically. In the case of Mendums, water drawdown begins in November and usually ends at the end of February. However, Water Resources personnel can manipulate the water level on a daily basis throughout the year. There is no set time for the water recovery rate of a drawdown lake and the recovery is dependent upon the winter's snowpack and spring rains.
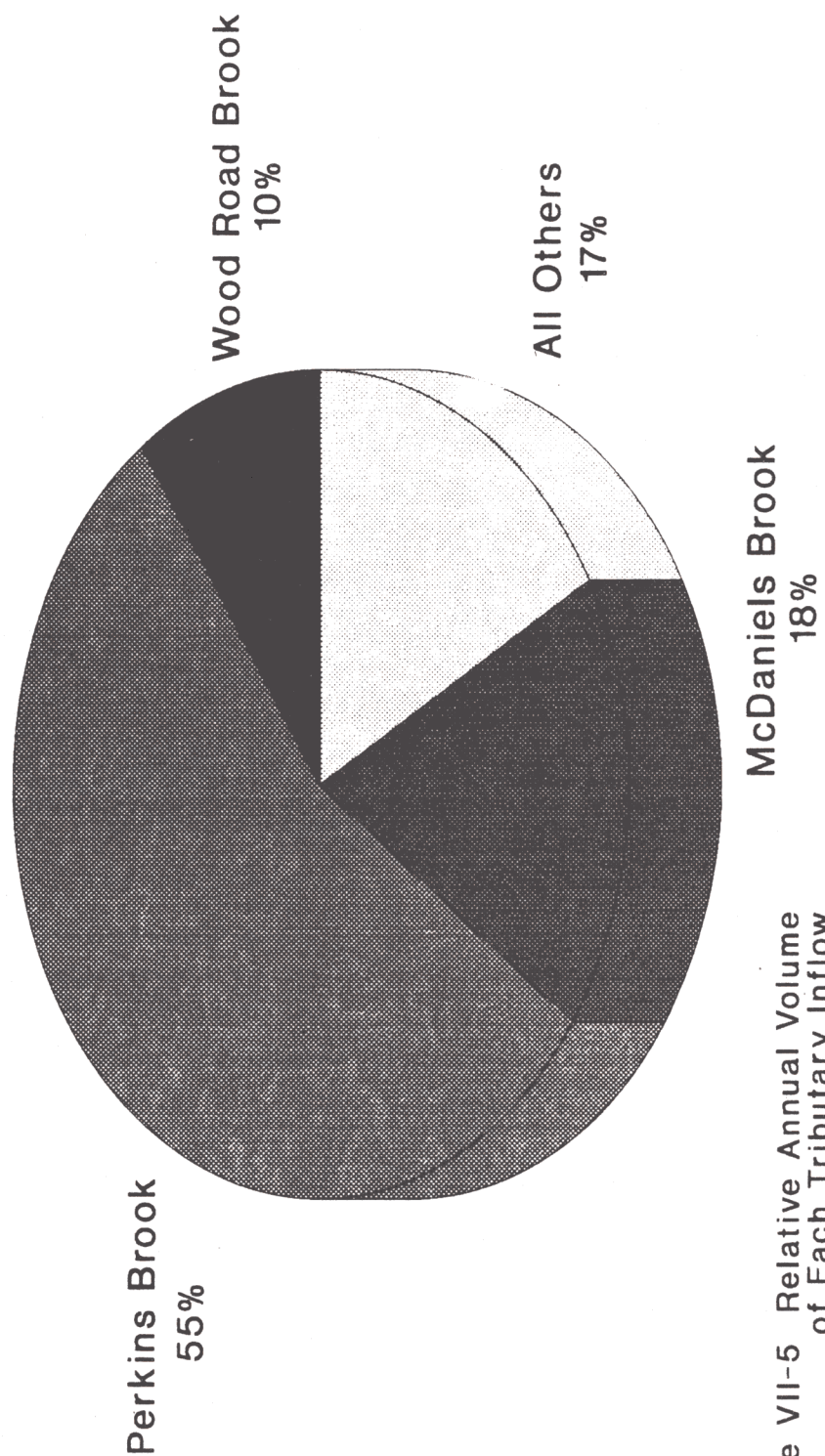
Mendums Pond
Percent tributary inflow

Wood Road Brook
10%

All Others
17%

McDaniels Brook
18%

Perkins Brook
55%

Figure VII-5 Relative Annual Volume
of Each Tributary Inflow

Mendums Pond
Inflowing Component

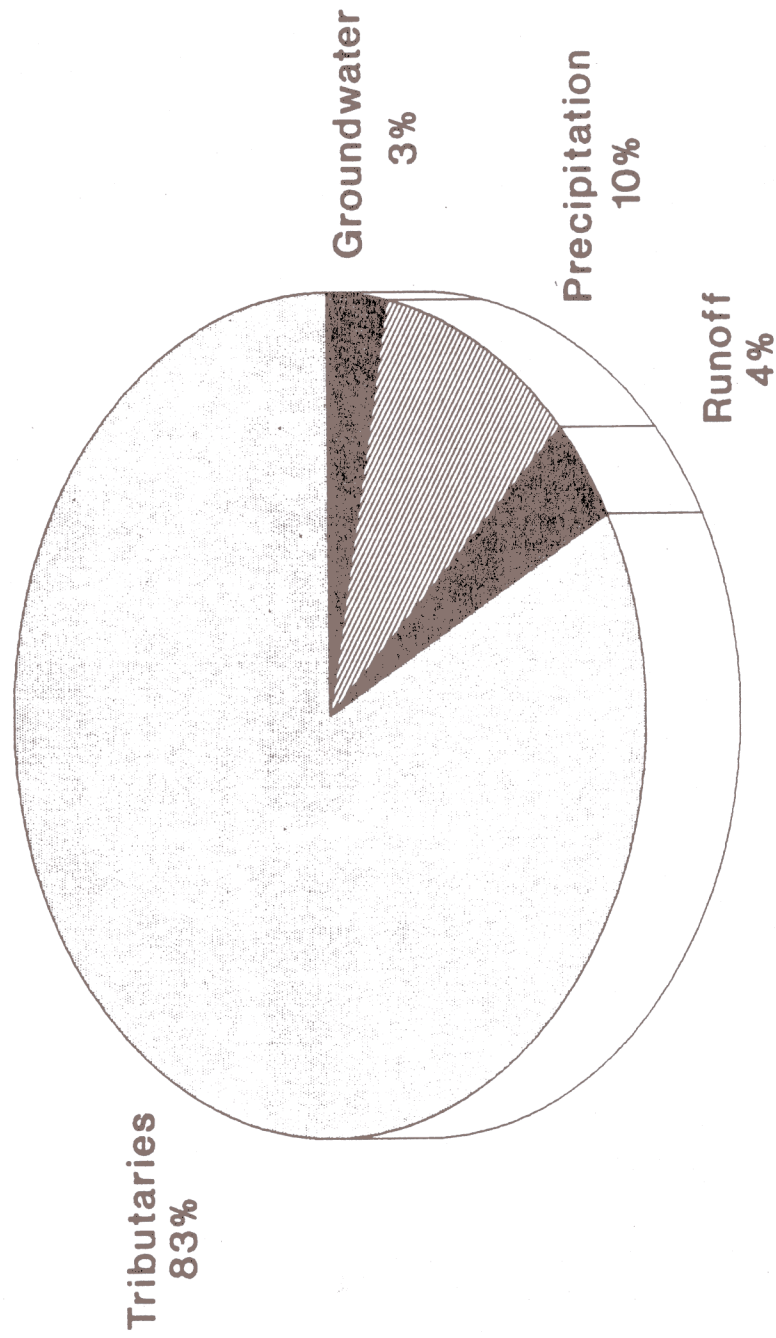Groundwater
3%

Precipitation
10%

Runoff
4%

Tributaries
83%

Figure VII-6. Relative Annual Volume of
Inflowing Component

Table VII-5
Mean Monthly Hydrologic Discharge Values for Mendums Pond Outlets (10^3m^3)

	Dam	Spillway
Nov 87	*1387.5	* ----
Dec 87	*1029.0	* ----
Jan 88	* 993.7	* ----
Feb 88	*1083.6	* ----
Mar 88	* 7.6	* ----
Apr 88	* 7.3	*800.2
May 88	7.6	1168.2
Jun 88	7.3	110.1
Jul 88	7.6	634.6
Aug 88	7.3	946.0
Sep 88	7.3	579.9
Oct 88	469.1	145.5
Total	5015.2	4384.5
Mean	418.0	365.4

*Pond water level manipulated by NHDES personnel (drawdown/refill via dam boards)

Mendums Pond
Seasonal Outflow Distribution

Winter
33%
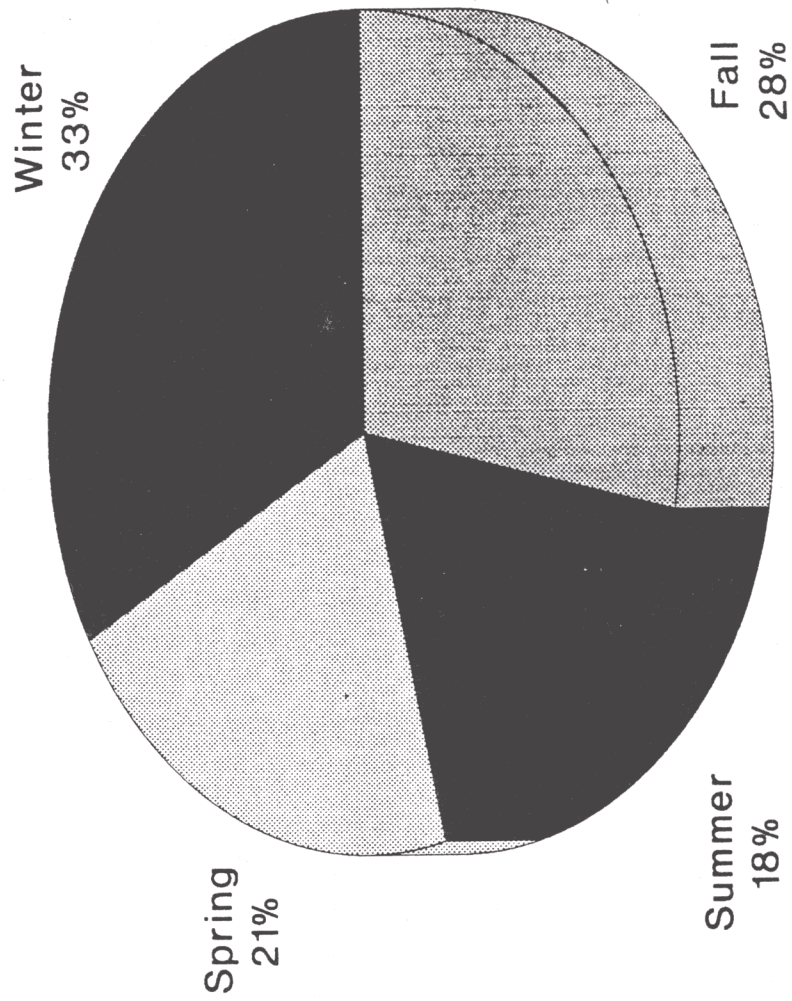
Fall
28%

Spring
21%

Summer
18%

Figure VII-7. Mendums Pond Seasonal Outflow Distribution

The study year hydrologic budget showed that drawdown occurred between November through February as 48 percent of the water exited Mendums Pond during the four month period. Seasonally, winter marked the greatest volume of water release from Mendums (33 percent).

The recovery period occurred during March and early April. Less than 1 percent of the total volume exited through the outlets during March. On a seasonal basis, the spring with 21% and the summer with 18 percent marked the lowest discharge of water from Mendums Pond. Water discharge during the fall accounted for 28 percent of the total annual outflow.

Figure VII-8 compares the hydrologic outflow components of Mendums Pond. Water flowing from the lake via outlet structures accounted for 92 percent of the total discharge volume at Mendums Pond. Evaporation depleted five percent of the water leaving Mendums Pond. The summer months accounted for 62 percent of the evaporated water portion. Groundwater recharge was estimated to be only three percent of the total discharge volume from Mendums Pond.

2. Stormwater Hydrology

Although a stormwater event was not part of the study requirements, theses events can have a dramatic effect on lake hydrology and quality.

Stormwater runoff is a principal cause for degradation of rural lakes where agricultural runoff is present (Cooke et. al, 1986). Runoff water will likely contain the impurities in precipitation plus debris and other impurities deposited on the ground surface. Pollutants diffuse over the surface of the land and eventually enter the aquatic system (Wanielista, 1978).

Two types of storm events are important to the hydrologic and nutrient budget. High intensity,short duration storm events can represent a high percent of the total water budget and a significant percent of the phosphrus export to a lake. Since less water is able to percolate into the ground in high intensity storm events, more unfiltered surface runoff and more erosional material is carried to the lake and its tributaries.

Mendums Pond

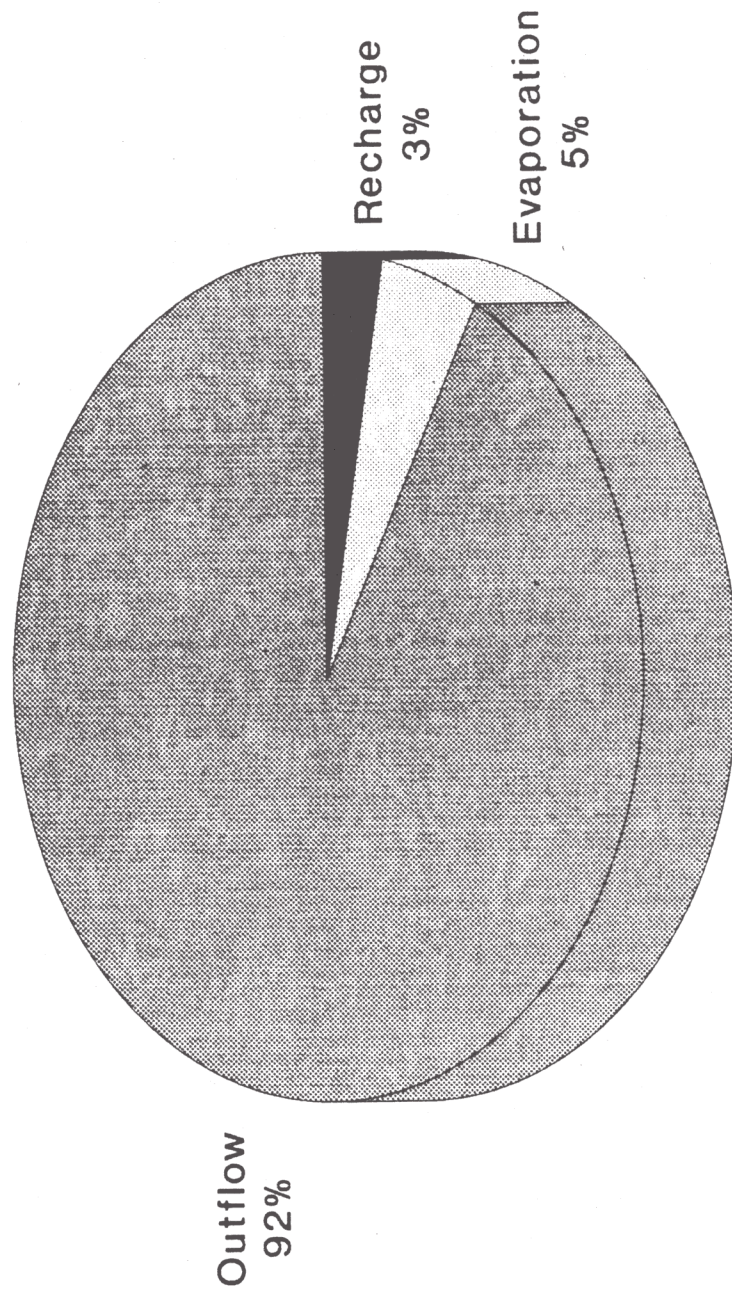## Hydrologic Budget Component Distribution

Figure VII-8 Hydrologic Budget Outflow Component Distribution

Low intensity, longer duration, events can also be significant to the hydrologic budget but usually have a lesser impact to the nutrient budget. More water infiltration to the ground allows less direct surface drainage into an aquatic system. Low intensity rain events do increase groundwater seepage rates in the lake and tributaries (Connor, 1979). However, the lake quality impacts in referene to erosion and phosphorus exports are less severe than a high intensity event.